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Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

Rock Products
Machinery

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Rock Products Machinery

ROCK products became one of the dominating industries with the extension of our modern system of highways which resulted from the development of automotive transportation. That called for huge volumes of crushed gravel, slag, stone and cement of various sizes, from coarse material used for foundation courses through the intermediate sizes used for asphalt pavements to material of extreme fineness such as fillers and quick setting cements. Quarrying had been practiced since the Romans built their famous roads and aqueducts; stone-cutting since the days of antiquity. But neither was a coordinated industry, nor did it lead to the development of machinery when we entered the so-called machine age. The quarry-man adopted existing devices which had been developed more specifically for mining.

Builders of crushers, pulverizers and screens, however, were not content to borrow as better grading and finer screening was necessary when the use of asphalt fillers and portland cement became wide spread. Their cue was to go back to the source and study ways and means of perfecting crushing and grinding machinery which would give the required output dependably at minimum cost for operation. They realized the importance of lubrication and the rock products industry profited accordingly. In turn, builders of lubricating equipment studied the requirements of this type of heavy duty machinery along with the operating conditions. Then, in conjunction with designers, bearings, gears, methods of sealing, housing and lubricant circulation were perfected.

The results of these studies are noteworthy, for they produced a type of heavy duty machinery which is distinctive for its utilization of means of automatic lubrication and the protection afforded the moving parts in the presence of abrasives which otherwise would quickly ruin a set of bearings or gear teeth.

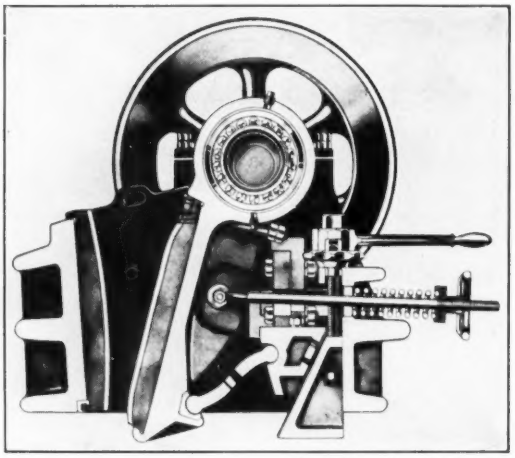
Handling of rock products requires machinery capable of crushing and grinding to successively finer materials. Essentially two distinctive types of operation are involved. The raw product must first be crushed on heavy duty machinery, after which grinding and pulverization to accurately graded sizes is usually necessary. The jaw crusher, gyratory or heavy roll crusher does the primary reducing; roll, ball or tube mills are used for final reduction where accurately controlled fineness is required. Grading involves a third step in the separation of the fines by means of screens.

CRUSHER OPERATION

The jaw crusher is a primary breaker in that it is capable of taking rock and ore as blasted from the quarry or mine, reducing the size sufficiently to permit of secondary treatment where necessary. Jaw crusher design requires a hollow rectangular frame with a renewable breaking plate or die fixed at one end; opposing this is a lever or swinging jaw to which is attached a similar breaking plate. The fixed die is vertical—the swinging jaw being set at an angle and arranged to swing back and forth at controlled intervals and at considerable speed. In this way it puts crushing pressure upon the rock which is fed into the space between the breaking plates. Thus, a large lump of rock introduced at the top of the opening gradually is made smaller and smaller by the repeated blows of the swinging jaw until the

pieces are small enough to drop through the discharge opening.

The swinging jaw is actuated by a link arrangement known as the pitman which is



Courtesy of Iowa Manufacturing Company

Fig. 1—Details of a "Cedar Rapids" Roller Bearing Crusher.

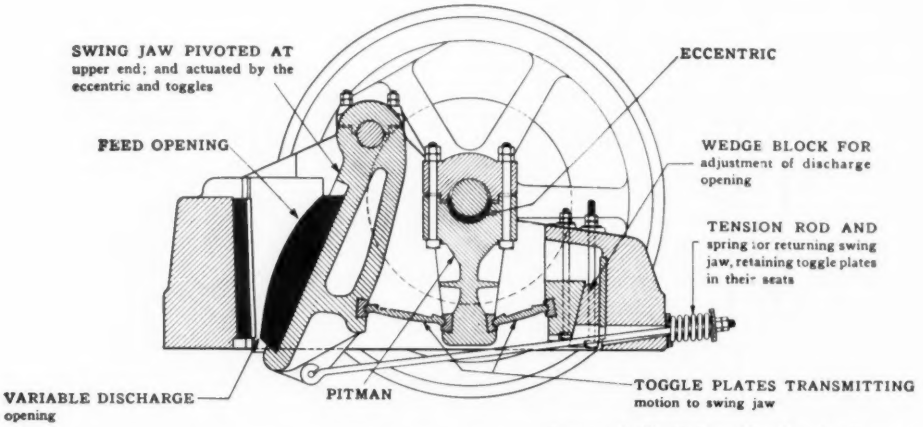
suspended from bearings integral with the frame and located about midway between the swinging jaw and the rear of the frame. The pitman is capable of vertical rolling motion developed by the turning of its eccentric shaft. This motion is transferred horizontally to the swinging jaw by the toggle action of two flat plates which are held by knuckle joints to the back of the swinging jaw, the pitman and the lower part of the frame. The weight of the swinging jaw keeps this toggle mechanism in proper position.

heavy loads with evenly distributed pressure and the facility with which replacement can be made if necessary. These bearings are provided for pressure lubrication and water cooling. Grease seals and flexible dust guards are also applicable to reduce the extent of contamination of the lubricant and enable maintenance of pressure on the lubricating film by retarding leakage. This is especially important in the lubrication of heavy duty machinery where lubrication under pressure must be depended upon to partially counteract the mechanical pressure developed by the moving parts during operation.

Pitman and eccentric shaft bearings must always be very carefully lubricated. The former carries the pitman or heavy steel casting which oscillates with its bearing as the point of suspension. Water cooling is very advantageous, for this bearing will often tend to overheat. Links or coiled springs can also be used to good advantage in order to relieve the pitman bearing of some of its load.

Grease lubrication is usually employed on this bearing due to the ease with which it can be applied either by a pressure lubricator or by means of a reservoir provided with a wool yarn or pad retainer which will insure positive lubrication without too much loss.

A medium to heavy grease containing a comparatively heavy oil is required for pressure lubrication. Pad lubrication, however, requires a lighter product sufficiently fluid to penetrate readily through the wool yarn or pad. A metal screen placed in the bottom of the reservoir will prevent strands of wool from working into the bearing clearance. Regardless



Courtesy of Allis-Chalmers Manufacturing Company

Fig. 2—Section through a Blake Crusher with all parts identified.

Bearing Design

Jaw crushers use sleeve or roller bearings to good advantage due to their ability to carry

of the means of application, it is obvious that the lubricant must completely fill the clearance spaces at all times, and be sufficiently plastic

to resist being squeezed out from the high pressure zone. Some crusher builders make sure of this by providing pressure gun inlets at two points.

The eccentric bearings also may be subject to loads comparable with the pitman bearings. This will be especially true if the weight of the pitman is not balanced by springs, in which case the full weight will be exerted upon the eccentric bearings.

Crusher construction, therefore, must always be carefully studied by the lubricating engineer. Final decision as to any lubricant should only be made after consideration of the probable loads developed at the bearings and the means available to provide lubrication at the points of maximum pressure to counteract these loads. Constant pressure on the lubricant is definitely advantageous in this regard.

Lubrication of toggle seats also is dependent upon design. As rolling motion is developed, the duty imposed upon the lubricant is less severe. Some sliding motion will always prevail, however, so these mechanisms should not be overlooked. Usually a relatively heavy machine oil will suffice, being applied by sight feed oil cups.

THE GYRATORY

The gyratory is also a primary breaker in that it is capable of taking quarried or mined materials for direct reduction in size. The gyratory crushes through the circular rolling motion of the crushing head, which is driven by gearing or belt drive through an eccentric at the bottom of the shaft. During the circular rolling motion of the head it successively approaches every point of the interior of the throat to develop a continuous breaking of the material to be crushed.

Features of Design

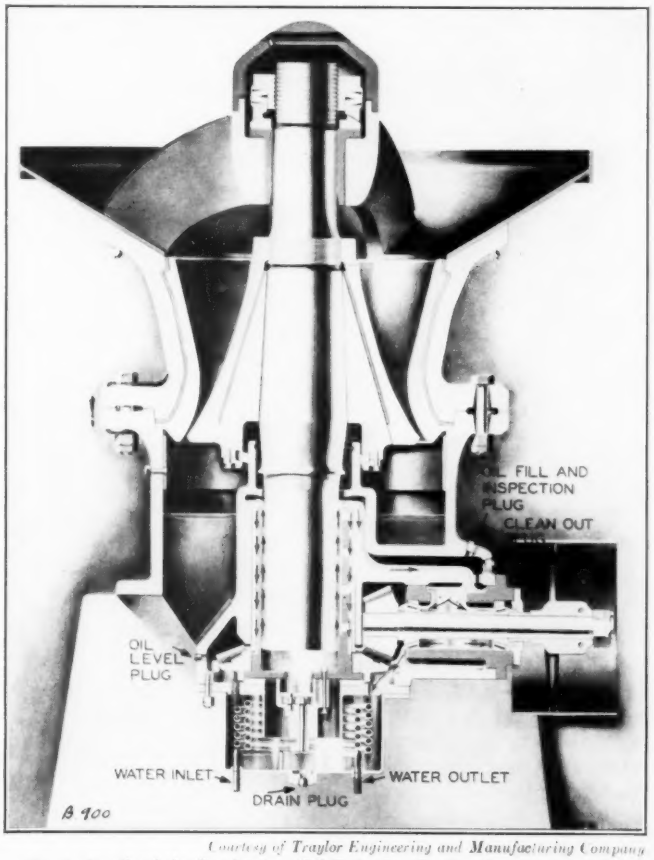
The gyratory may be of the geared or gearless type. Lubrication of the former is the more involved due to the presence of gears and countershaft bearings. The latter may sometimes be ring-oiled though the duty they perform along with the probable entry of dust or grit may render this an unnecessary refinement. Sight feed oil cups or compression grease cups are most usually employed especially as the speed conditions will rarely exceed 600 r.p.m.

Ring oiling, of course, provides some washing action; consequently, any dirt or grit normally will be washed out of the clearances by oil and carried into the reservoir below. This latter, however, must be of adequate capacity; it must also be cleaned frequently, otherwise the accumulations of abrasive foreign matter might so contaminate the oil as to cause serious abrasion of the journal and bearing surfaces.

Countershafts are sometimes fitted with outboard bearings in order to steady the shafts and reduce the load on the main bearing. Irrespective of design, however, it has been determined that a heavy engine or machine oil ranging from 500 to 750 seconds Saybolt Universal viscosity will usually afford adequate protection. Climatic conditions of course must always be considered in selecting this oil, using the lighter grade for low temperatures. Low pour test is also beneficial under these conditions as it assures of better fluidity.

Gear Requirements

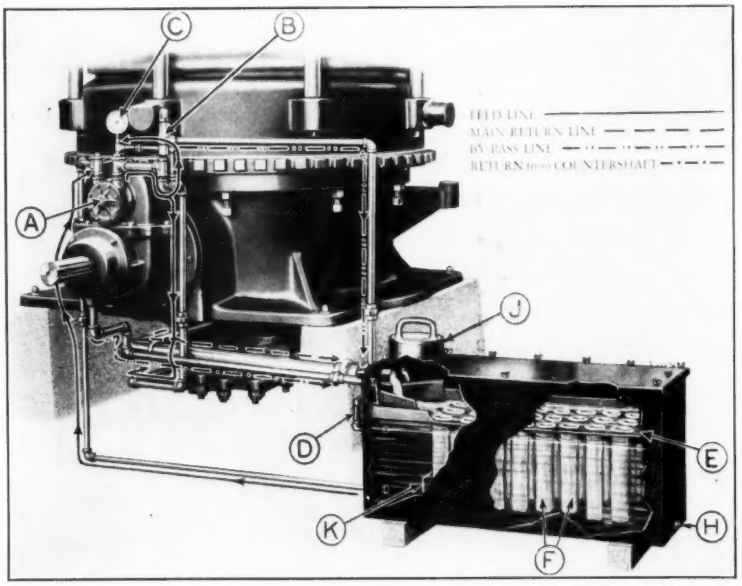
Gearing in the gear-driven gyratory is subject to severe service. Accordingly the manufacturers make every provision to prevent contact with abrasive foreign matter. The gears are housed in oil-tight cases and dust rings are



Courtesy of Traylor Engineering and Manufacturing Company

Fig. 3—Details of the Traylor type TY Reduction Crusher showing dust seal and lubrication system.

fitted on each shaft where it enters the gear case. Even so some contamination of the gear lubricant will occur.



Courtesy of Smith Engineering Works

Fig. 4—Showing flow of oil to and from a Telsmith Gyratory Crusher. Note Filter bags at F; baffle plate K; oil pump A; inspection cover J; and drain plug H.

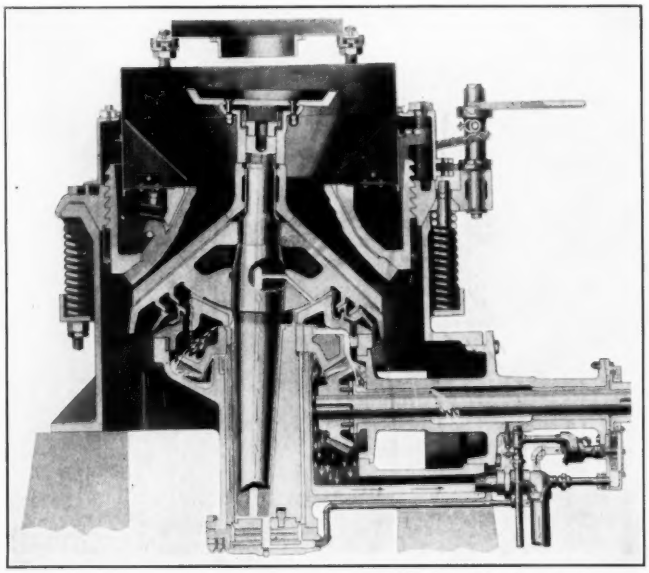
For this reason gear lubrication has been carefully studied. The lubricant must not be too thin or too low in viscosity otherwise its protective or cushioning ability may be inadequate to prevent the teeth from actual contact under heavy loads. Conversely, too heavy a lubricant would hold any grit or dust in suspension and permit it to develop a scoring action on the gear teeth.

Experience has indicated that a gear lubricant of from 90 to 140 seconds Saybolt Viscosity at 210 degrees Fahr., will usually be most dependable. An oil within this viscosity range will resist the drying action of dust and prevent its packing between the teeth of the gears, thus obviating any tendency in the latter to spring and throw any unnecessary pressure on the countershaft bearings or eccentric. In cold weather a gear lubricant just like a bearing oil should have low pour test so that it will flow dependably. This will reduce drag, power consumption and the possibility of inadequate lubrication.

The Eccentric

The eccentric develops the necessary gyratory motion for the main shaft; this must be maintained at a uniform rate so that maximum crushing ability will be developed with minimum power consumption. Lubrication must therefore be most carefully studied. As the eccentric revolves in a bushing and around a shaft there are two surfaces to be lubricated. In addition there is the brass wearing ring which carries the weight of the bevel gear and eccentric. In some machines the base is also designed to fit loosely in the eccentric to enable tipping from side to side. This action may lead to serious overheating and wear unless adequate lubrication is maintained, for all the pressure will be periodically imposed upon a comparatively small area near the top of the thickest part of the eccentric sleeve.

This has led to the almost universal adoption of automatic lubrication by oil delivered under constant and positive pressure to the mechanisms in question. Fluid lubrication of this type is distinctly advantageous in that not only does the oil serve as a lubricant but also, to some extent, as a coolant to remove heat. Furthermore, the pressure under which



Courtesy of Nordberg Manufacturing Company

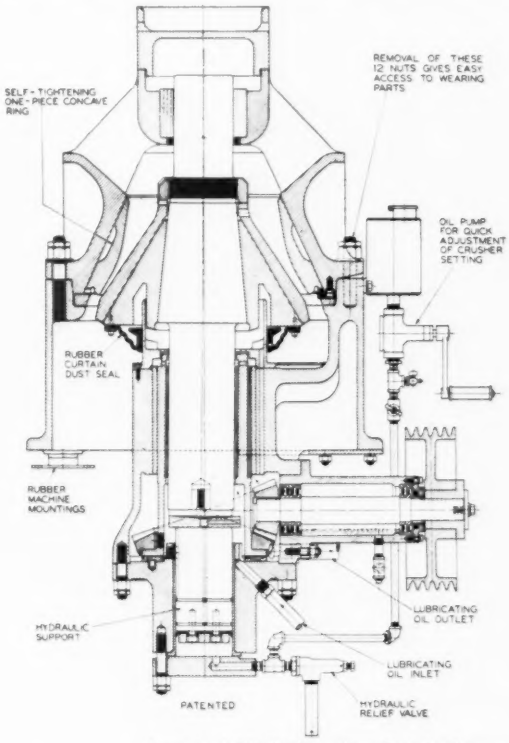
Fig. 5—Lubrication system for the Nordberg Symons Cone Crusher. Arrows show flow of oil.

it is circulated also tends to counteract somewhat the mechanical pressure developed when the gyratory is in operation.

The lubricating system on the gyratory is very carefully planned. Oil circulation is maintained by means of an oil pump located at the base of the crusher either within or adjacent to the oil reservoir in the bottom plate. An ample supply of oil is contained in the system, which, as a rule includes a suitable filter or strainer through which the oil is continually passed. This together with the general dust-proof construction insures against entry and circulation of an excess of abrasive matter through the system. So all the lower moving parts are served with a flood of clean, cool oil all the while the crusher is operating, for the oil pump starts simultaneously with the latter and operates at a predetermined speed according to the speed or rate of crushing of the gyratory.

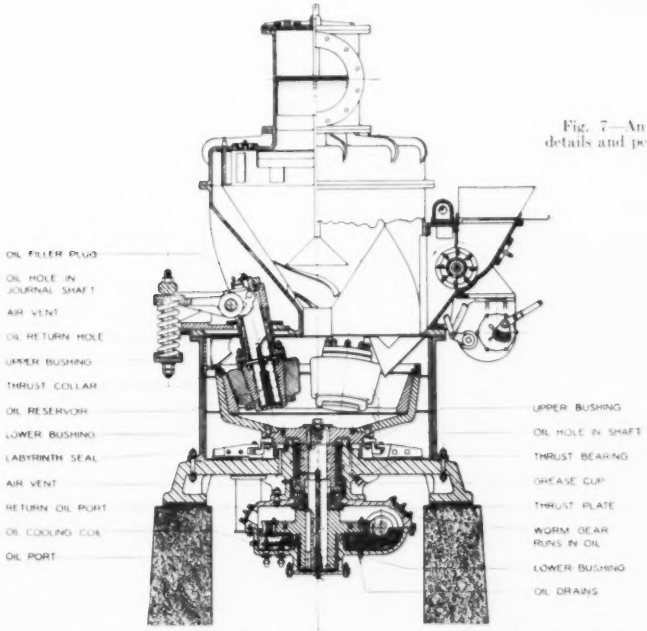
Temperature Control

Oil temperature control is maintained by including suitable coils in the base of the oil reservoir through which hot or cold water can be circulated according to the prevailing outdoor temperature. Warm or hot water circulation is especially helpful when starting in cold weather. It will decrease the frictional drag which would otherwise develop within the oil due to the increase in viscosity. Oil heating in cold weather also reduces the load on the oil pump. Under normal conditions of crushing, provided there is ample oil capacity, overheating even in warm weather will be unlikely, unless very hard rock is being handled. Under these conditions oil cooling is beneficial.


REMOVAL OF THESE 12 NUTS GIVES EASY ACCESS TO WEARING PARTS
SELF-TIGHTENING ONE-PIECE CONCAVE RING
OIL PUMP FOR QUICK ADJUSTMENT OF CRUSHER SETTING
RUBBER CURTAIN DUST SEAL
RUBBER MACHINE MOUNTINGS
HYDRAULIC SUPPORT
LUBRICATING OIL OUTLET
LUBRICATING OIL INLET
PATENTED
HYDRAULIC RELIEF VALVE

Courtesy of Allis-Chalmers Manufacturing Company

Fig. 7—An Allis-Chalmers Reduction Crusher showing structural details and pertinent parts of the oiling system.



Courtesy of Raymond Pulverizer Division, Combustion Engineering Company, Inc.

Fig. 6—Diagram of the Raymond Bowl Mill oiling system with parts indicated.

The Eccentric Sleeve

Bath or flood lubrication is also applied to the eccentric sleeve. Here again the oil bath lubricates and cools. Where no oil pressure is provided, the rotation induces oil circulation by capillary attraction, the oil passing up through the clearance space around the journal, over the brass wearing ring and back through passages to the reservoir below. This is a simple and expedient method of maintaining dependable lubrication provided fresh makeup oil is added regularly (as experience indicates) and provided the reservoir is drained and cleaned regularly to remove accumulations of foreign matter before it can do any damage.

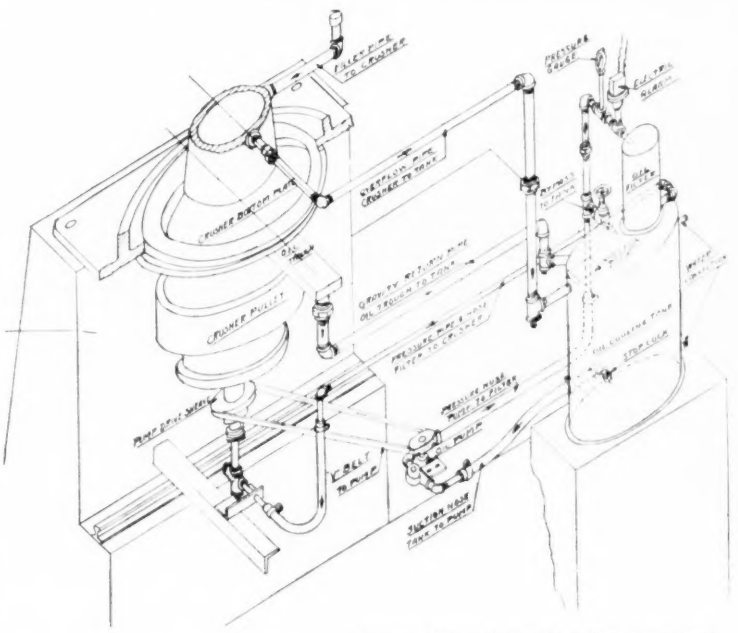
Relation of Temperature to Oil Viscosity

Lubrication of the gyratory can be main-

tained normally by a straight mineral oil of from 60 to 140 seconds Saybolt Viscosity at 210 degrees Fahr. In cold weather an oil approaching the lower figure of this range is advisable; conversely, for high temperatures. It depends largely upon the provisions for heat exchange, i.e., heating or cooling, and the temperature of the inlet water. Under extreme conditions oils of even lower or higher viscosity may be advisable.

Wearing Rings

The top bearings along with the suspension or wearing rings are contained in a spider at the top of the main shaft. These must also be carefully lubricated using an oil of sufficient body or viscosity so that it will not run prematurely through the clearances. Usually a straight mineral oil comparable to a light cylinder oil will meet this requirement. To facilitate retention of oil the space within the cap can be packed with a pad of wool yarn saturated with oil. By keeping this well loosened and not allowing it to pack or mat, relubrication, by adding a few ounces of oil daily applied via the oil hole in the spider cap will suffice.



Courtesy of Kennedy-Van Saun Mfg. & Eng. Corp.

Fig. 8—Isometric view of the lubricating system for Kennedy Gyratory Crushers.

VERTICAL RING GRINDING

In contrast with the conventional gyratory which crushes on more or less of a horizontal anvil ring, we must also consider those machines which crush over a vertical ring with crushing pressure developed through spring action. In such mills a steel anvil ring is supported and revolved by a large horizontal gear-driven shaft. Hammer rolls are held against the inner surface of this ring by means of springs. In operation the material to be crushed is delivered to the point of crushing through a spout, being kept at the ring surface by centrifugal force.

Other types of vertical ring crushers are driven through the top hammer roll instead of the ring. This is accomplished by direct motor connection or a belt and pulley. The movement of the top roll causes the ring to revolve; this in turn actuates the lower rolls.

Lubrication Requirements

Those parts which require lubrication are the bearings of the hammer rolls, the ring shaft, the pinion shaft and the gears which comprise the drive.

The hammer rolls are frequently mounted on roller bearings enclosed in dust-proof housings. These elements operate normally in a bath of oil which is contained in, and circulated from, a reservoir fixed to the end of the hammer roll shaft.

This oil should be a straight mineral product of sufficient viscosity to insure adequate body to prevent metal-to-metal contact at the operating temperatures. As we are involved with flood lubrication this oil should never be so heavy as to become sluggish and resistant to circulation. As a rule a viscosity range of from 500 to 750 seconds Saybolt at 100 degrees Fahr. will meet normal requirements.

Ring shaft bearings in turn present no difficulty as to lubrication provided they are kept free from dust or other non-lubricating matter. Speeds are low and loads are normally well-balanced. Oil lubrication by means of oil-saturated wool yarn, or a light grease will give ample protection. The same applies to the pinion shaft bearings, though the operating speeds are somewhat higher.

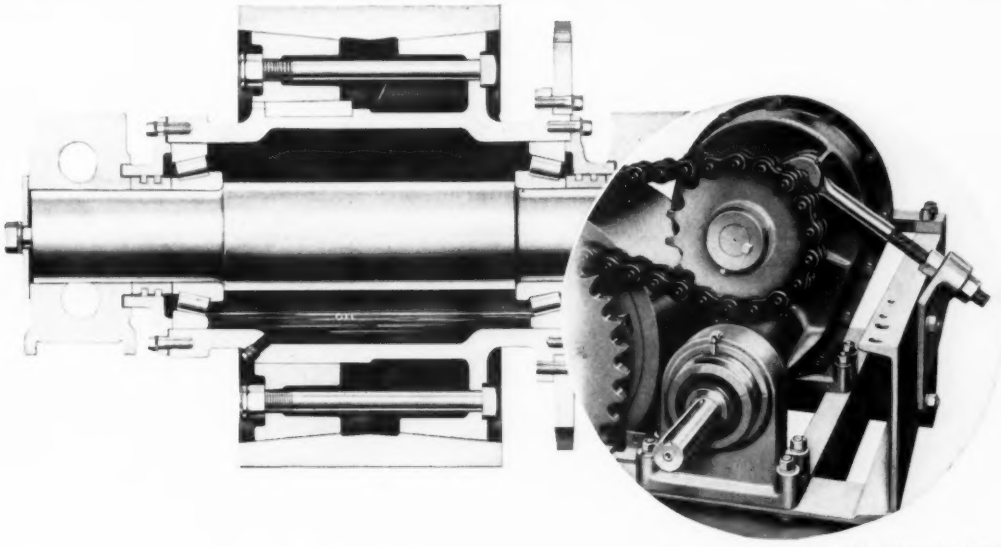
Gear lubrication also is simplified by the means which are provided to prevent contamination of the lubricant. Furthermore, as the gear housings are oil-tight and dust-proof, bath lubrication is practicable using a light gear lubricant. This will resist throw off and func-

tion satisfactorily under the prevailing case temperatures which are usually moderate.

Lubrication of ring crushers which are driven through the top roll involves the bearings on

SECONDARY CRUSHING OR GRINDING

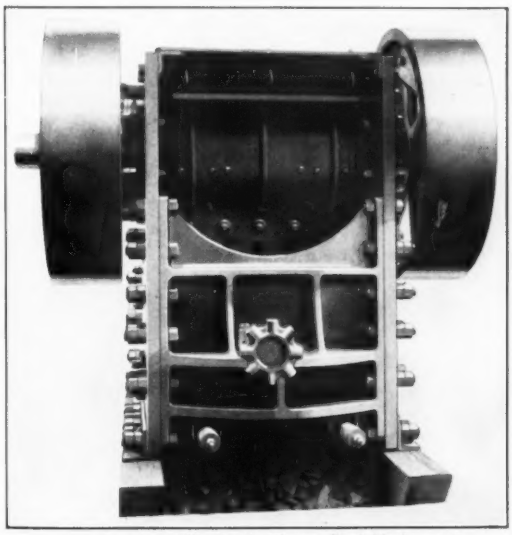
When rock must be pulverized, after primary crushing, it is run through a set of secondary reducing units. These will usually involve ball,



Courtesy of Smith Engineering Works

Fig. 9—At left, see sectional view of a fixed Telsmith roll assembly, on which the anti-friction bearings run in an oil bath. At right, note back gear and chain adjustment mechanism.

each of the hammer roll shafts. These are long and fitted with collars to exclude dust or grit. Each bearing is equipped with a large reservoir capable of holding a quantity of grease which



Courtesy of The Austin-Western Road Machinery Company

Fig. 10—An Austin-Western Crusher with provision for pressure grease lubrication.

is fed in via grooves on the low pressure side. A light, well refined grease will function satisfactorily as no unusual lubrication problem is involved.

rod or compartment mills, or a cone crusher, which produce a final product of remarkably uniform fineness. Cement rock is treated in this manner. Here the rock must be ground just as finely before burning as after.

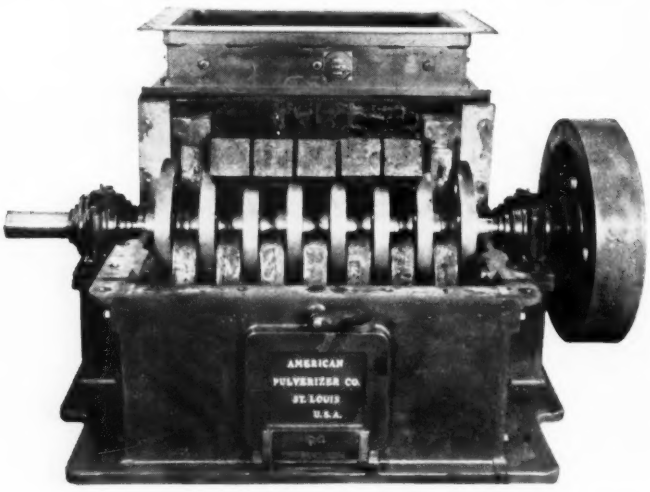
A typical grinding mill involves a horizontal steel drum which is partially filled with steel balls or rods. The drum is rotated through a set of enclosed reduction gears by motor power. As it turns the balls or rods roll continually to the bottom, grinding the particles of rock between and beneath them.

Machines of this type are carried on horizontal bearings which are often subject to heavy loads. The conditions are aggravated by the possibility of grit or dust gaining entry to score the bearings. So every precaution possible is taken in design to keep this dust out of the bearings. For this reason they are comparatively large, in order that the unit loads may not become excessive. In spite of this, however, a fairly heavy lubricant must be used, in order to prevent undue frictional heat. Fortunately speeds are low, so there is no objection to a heavy lubricant from this angle. In other words it is practicable to use a medium to heavy grease; this will seal effectually against entry of foreign matter and also carry the prevailing loads satisfactorily.

Temperature Control

Bearing temperature may be caused to rise due to the entry of abrasive dust, use of an

unsuitable lubricant, insufficient lubrication or on account of some mechanical fault such as misalignment or insufficient clearance. Transmitted heat must also be considered, as for example when grinding relatively hot materials.



Courtesy of American Pulverizer Company

Fig. 11—View of an American Hammermill Crusher with back cover removed to show the rotor and anti friction bearing assembly.

Overheating should be corrected as soon as possible, even though this may require stopping the mill. Where it is not practicable, the troublesome bearing can be loosened, flooded with cylinder or crusher oil or subjected to external cooling by a fan. At the first opportunity the bearing should be examined to see that the grooves and lubricant feeds are clear and not clogged. If the temperature has risen sufficiently it is important to remember that the bearing metal may have become soft enough to wipe. This is a good time to correct any suspected difficulties.

Trunnion Bearings

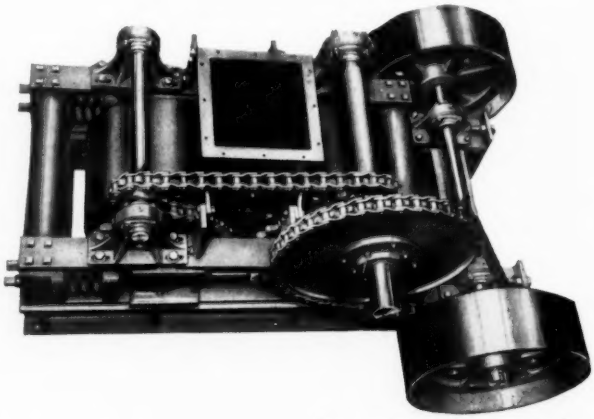
Ball or tube mills in cement manufacture may be carried on trunnion bearings. These may be troublesome due to the heavy loads which must be carried, the possible entry of dust and grit and the probability of heat being transmitted to the bearings from the shell.

These bearings are comparatively large. Sometimes they are lined on the bottom half only since the direction of load is always downward. This facilitates relining if the bearing metal becomes worn or unduly scored. The bearing cap in such cases serves as a dust shield and if desired as a receptacle for the grease used in lubrication. This latter should be a carefully refined, fibrous grease of high melting point. Wherever wool yarn packing is desired a lighter grease or a high grade crusher oil is used. The wool yarn serves as a seal or strainer to prevent dust or dirt from getting to the bearing. In addition provisions for cooling water circulation will control the bearing temperatures effectually.

Automatic Lubrication

Mill bearings of the two-part type can also be designed for automatic lubrication. Here the cap as well as the bottom half is lined. Oil is carried in a suitable reservoir below the latter being distributed by a dipper device which is rotated by the shaft. The usual construction provides for two of these dippers which at every rotation automatically fill themselves with oil to empty it along the top of the shaft. From this point it is distributed throughout the clearance space. When these bearings are water-cooled the temperature is so controlled that a medium to heavy viscosity oil will give ample protection. With bearings of this type there is but little chance for entry of abrasive foreign matter. Furthermore, as they are flooded with oil any dust or dirt which may be present will be flushed down into the reservoir. Normally it will settle here and can be removed by draining at periodic intervals.

Roller bearings are also adaptable to trunnion service. They are regarded as being quite as advantageous as the self-oiling plain bearing even though the former may not have as ample a lubricant reservoir. Either oil or grease can be used according to the type of seal and the means of relubrication provided by the designer.

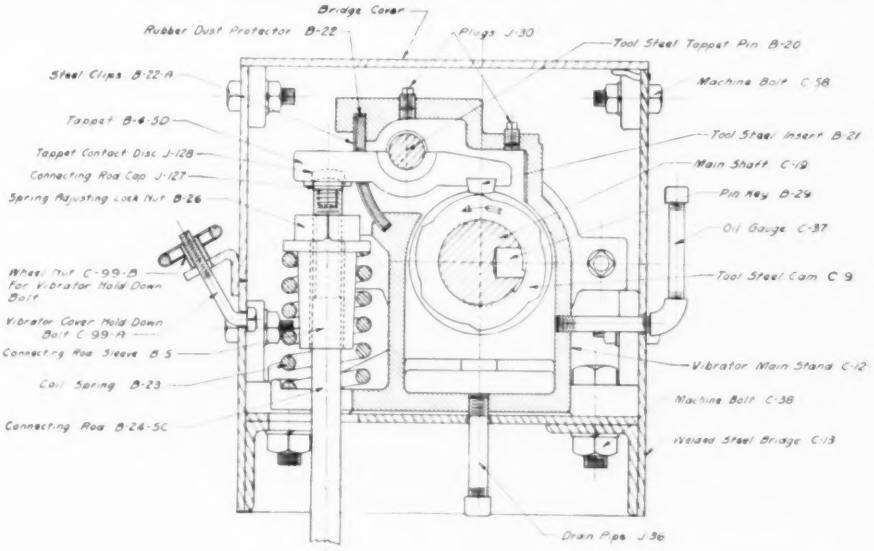


Courtesy of Diamond Iron Works, Inc.

Fig. 12—Top view of a Diamond Roll Crusher showing roller chain assembly. The rolls are mounted on Timken roller bearings.

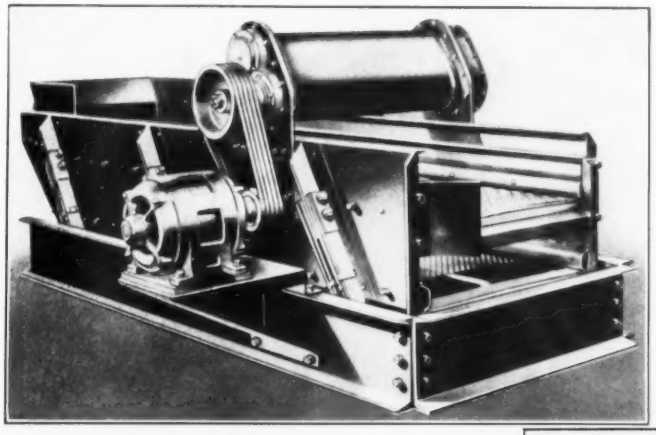
Ring oiled bearings are another type of self-

lubricated mechanisms which can be applied to ball and tube mill machinery. They are aptly applied to pinion shafting. Such bearings are best served by a light-medium straight mineral oil of around 300 Seconds Saybolt Viscosity at 100 degrees Fahr. Ring oilers should be cleaned at regular intervals. At the same time fresh oil should be added. Most troubles with ring oilers will be due to the reservoirs being too small to allow the oil to cool sufficiently, especially if relatively high bearing temperatures prevail. Under such conditions it may be practicable to increase the oil capacity by tapping a short length of pipe into the lower part with a cap on the lower end. A longer period of rest is better than increasing the oil viscosity.



Courtesy of The Deister Concentrator Company

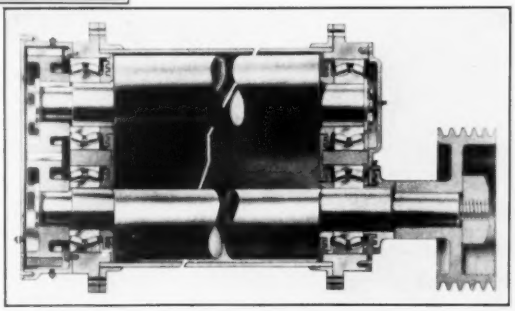
Fig. 13—Cross section of the vibrator mechanism on a Leahy Heavy Duty No-Blind Vibrating Screen.



Courtesy of Iowa Manufacturing Company

Fig. 14—A Cedar Rapids horizontal vibrating screen and its vibrating mechanism. Note that the bearings on the drive side are pressure grease lubricated, while those on the gear side are splash oiled by the same oil which serves the gears.

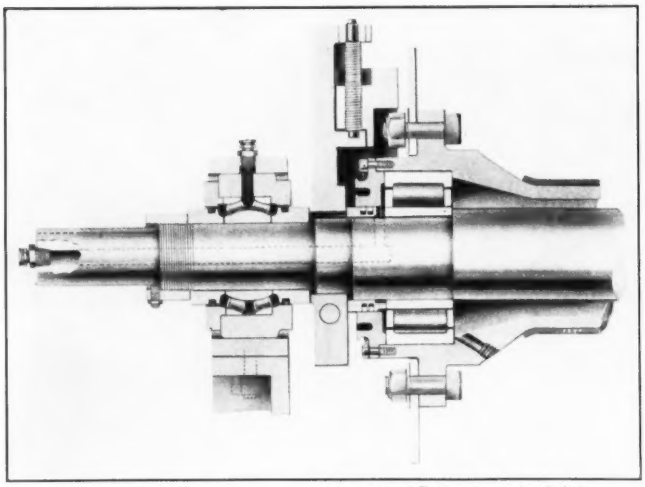
Mill trunnion bearings can also be fitted with wick feed oilers. They assure of positive lubrication and thereby render operation more dependable through reduction of bearing wear. This leads to reduced maintenance and repair costs. Wick oilers are particularly suited to existing installations due to their low initial cost and the ease with which they can be applied.



VERTICAL MILLS

The vertical mill also requires consideration as to lubrication. A distinctive type employs

four balls which roll around the internal circumference of a wearing ring or die at a speed of some 160 turns per minute. Pressure is thereby developed against the die to grind the material as it passes through.



Courtesy of Robins Conveying Belt Company

Fig. 15—Structural details of the Robins Gyrex Vibrator. Note provisions for pressure grease lubrication of the main and eccentric bearings.

We are principally concerned with lubricating the main shaft, the intermediate bearing, the lower bushing and thrust and the driving gears. Heavy oil or grease is used on the upper bearings according to the means for application. The lower bushing and thrust bearing, however, generally operate in a bath of oil. The same holds true for the driving gears. In both cases a light steam cylinder oil or crusher oil will be satisfactory. An exception might involve gears which may be subject to considerable dust contamination. Here a somewhat heavier gear lubricant will give better protection to the teeth. In addition to contamination, it must be remembered that the temperatures in these gear cases may be quite high though the loads are not abnormal.

THE HAMMER MILL AND RING CRUSHER

These units operate on the principle of reducing the material by striking it while in suspension. The hammer mill uses a series of hammers and the ring mill employs a series of manganese steel rings as the media of crushing. Crushing is brought about by the action of these hammers or rings upon breaking and grinding plates as the material is fed into the top of the crusher. The breaking plate is located above the grinding plate and does the primary breaking. The latter is adjustable so that the degree of crushing can be regulated.

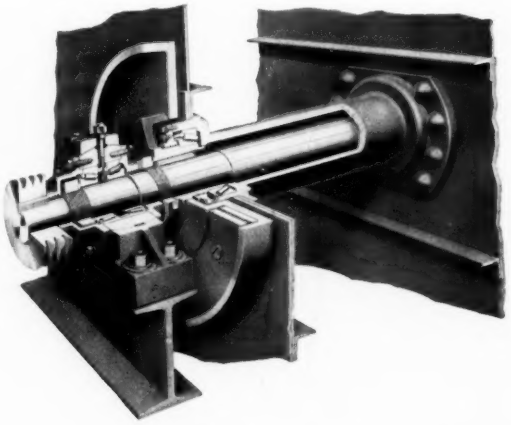
Lubrication is confined to protection of the spherical roller bearings which carry the rotor. As they are mounted in dust-tight, self-aligning pillow blocks lubrication can be effectually maintained by a suitable anti-friction bearing grease which is prepared especially to resist oxidation and bearing corrosion.

ROLL CRUSHING

The roll crusher is a versatile unit in that it can be used for either primary or finishing work, the design being planned accordingly. When crushing large volumes of hard rock or ore the shock loads are taken up by heavy duty steel spring assemblies. These along with their accompanying tension rods counteract any lifting action which may develop at the rolls.

A roll crusher consists basically of two hardened steel rolls of a size suited to the type of crushing to be done. Sleeve type bearings are widely used due to the flexibility with which they can be designed according to the prospective loads.

One of these rolls is normally equipped with fixed bearings, the shafts of the other being mounted in movable bearings to enable a certain amount of movement should non-breakable material be present in the rock. This allows such material to pass through without damaging the roll surfaces. These movable bearings in turn can be mounted in sliding pillow blocks equipped with riding plates for their support. This improves the flexibility of the assembly, reduces friction and wear and

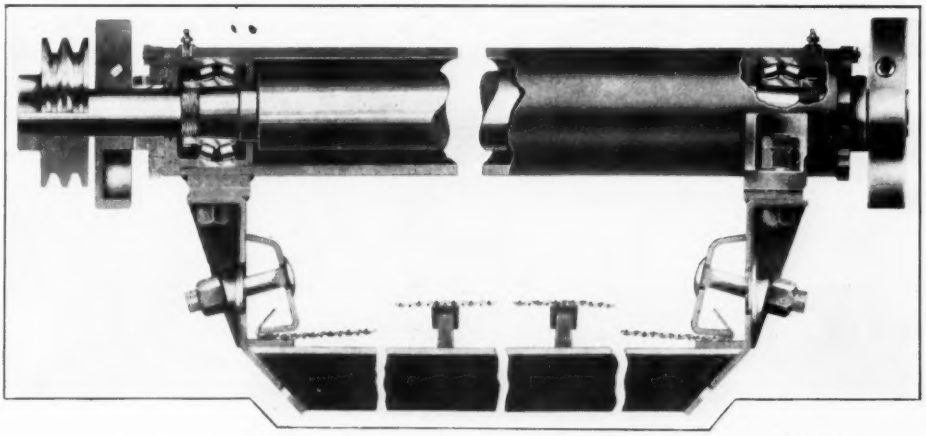


Courtesy of Kennedy-Van Saun Mfg. & Eng. Corporation

Fig. 16—Exposed section of the shaft and eccentric bearings of a Kennedy type "A" Vibrating Screen.

facilitates uniform distribution of pressure over the bearing surfaces. Adjustment is also simplified where change of roll setting is necessary.

But for the matter of load, roll crusher bearings will present no lubrication problems. Normally they can be lubricated by compression grease cups, or by wool-yarn grease or waste-packed reservoirs open to the shaft along the horizontal center line. Pressure gun fittings are used for applying lubricant to the riding plates. By maintaining adequate pressure and a constant film of grease on the contact surfaces, ample protection of these plates will be assured. The grease, however, must be of pressure-resisting characteristics. This requires that the oil used in compounding be comparable in viscosity to a straight mineral steam cylinder oil. On the other hand the grease should not be too heavy or inert otherwise ready handling by the pressure gun might be difficult. In turn it should not be too light to permit of premature running off or drip.



Courtesy of Link-Belt Company

Fig. 17.—Vibrator and cross section of a Link-Belt "UP" Unbalanced Pulley Type Screen, showing roller bearings and pressure grease lubricators.

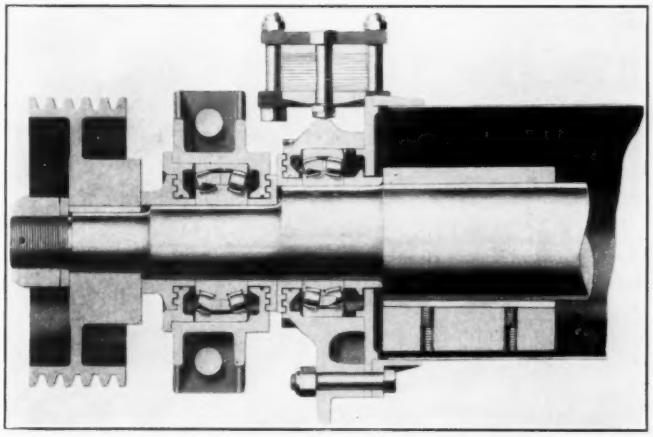
SCREENING AND SIZING

Rock products must be sized or screened after grinding and crushing to prepare them for subsequent usage. The size will range all the way from one to two inches in diameter (for example, the aggregate in concrete construction) to pulverized material approaching very fine mesh, as required in the manufacture of cement. In other words the extent to which the product is screened will depend upon the purpose for which it is intended.

Both rotary and vibrating screens are used for this purpose. The former are carried usually on two points of support—one at each end.

They are adaptable to stone quarry service. In design they consist of one or more cylinders or jackets composed of perforated plates. They are set on an angle so as to enable continuous travel of the product, which, as the screen rotates, falls through the perforations according to size.

Turning of a rotary screen is brought about at the driven end by means of gears, usually of the bevel type. The pinion or driving element is keyed to a shaft which in turn is belt or chain-connected through a speed reducer to an electric motor.



Courtesy of Nordberg Manufacturing Company

Fig. 18.—Section through the drive unit of a Symons Type F Screen, showing the eccentrics, shaft and roller bearings for the screening and balancing decks.

Vibrating or shaking screening for the purpose of classifying crushed materials accomplishes the desired result by the reciprocating

or vibrating action of the frame which holds the screen fabric with respect to the product. In other words it is like sifting ashes with a hand screen.

Vibration is the result of eccentric motion obtained by motor, chain or belt power. Screens of this type are generally set on somewhat of an angle, the product being screened wet or dry according to the nature of the process.

Screen Lubrication

The driving end of the rotary screen involves the necessary gears and bearings for speed reduction purposes. The gears will frequently operate exposed with their lubricants subjected to contamination by dust, dirt and probably moisture. Also in many cases they may be exposed to wide variations in temperature, which would likewise tend to reduce the efficiency of lubrication, unless the lubricant used has been specially refined to function and protect metallic surfaces under these conditions.

Lubrication of shaft and support bearings may also be affected likewise, although the housings, if properly designed and installed, will normally prevent the entry of an excessive amount of dust and dirt. As a rule plain babbitted bearings are employed, with provision for grease lubrication. Under the prevalent operating conditions grease is probably a better lubricant than oil due to its ability to maintain a more effective seal against entry of abrasive foreign matter. It must be a product of medium body or consistency, insoluble in water, however, due to the possibility of its having to withstand the washing action of rain, or any water used during screening. Pressure application by compression cup or pressure gun prevails.

Gears can be best protected by a lubricant which will not only form a protective film to counteract the abrasive effect of dust, dirt, etc., but will function irrespective of temperature, moisture, or weather conditions.

This is a broad requirement, one in fact that very few compounded lubricants or greases will meet with any degree of success. Experience has proven that a straight mineral residual product, of fairly inert characteristics, will give the most satisfactory results. Where means are provided to prevent loss of lubricant through abnormal dripping, a viscosity of approximately 140 seconds Saybolt at 210 degrees Fahr., will usually serve the purpose. High temperature operation, however, may require a lubricant of higher viscosity ranging perhaps up to 1,000 to 2,000 seconds Saybolt.

It is important to remember that some types of heavier lubricants will tend to pick up dust, which will ultimately ball up and scale, or be thrown off, leaving the teeth practically exposed. For this reason, the utmost care is necessary in choosing gear lubricants in order to make sure that they are refined to high lubricating and adhesive characteristics, which will render them capable of resisting the effects of centrifugal force under higher speed conditions. Where it is possible to enclose such gears the practice is very advisable. Not only will a housing serve to reduce the extent of entry of foreign matter, thereby promoting better lubrication, but also it will serve as a means of protection for the operator, by reducing the frequency of relubrication.

Grease lubrication has been found to be very satisfactory for the anti-friction bearings of vibrating or shaking screens, affording the requisite protection by preventing the entry of dust and dirt. As a rule, some form of compression or pressure grease lubricating device should be used to insure as nearly positive lubrication as possible. A medium bodied grease will be suited to such operations. Where desirable, as on certain types of anti-friction bearings, a medium viscosity straight mineral product is often used.

Eccentrics may also present a problem by running hot. Then we encounter the possibility of under-lubrication and abnormal wear of cams and straps. Cooling in emergencies must be effected by the best means available. Some use so-called cooling compounds applied by the lubricators; others use air fans. Lubrication in the meantime is usually maintained by a high melting point grease of relatively heavy consistency. The lubricating film developed by such a grease is decidedly tenacious, resistant to the thinning-out effects of higher temperatures and usually effectual in preventing eccentrics from overheating.

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PITMAN BEARINGS	
Waste Pad Lubricated	Texaco Car Oils or Texaco Pelican Oil
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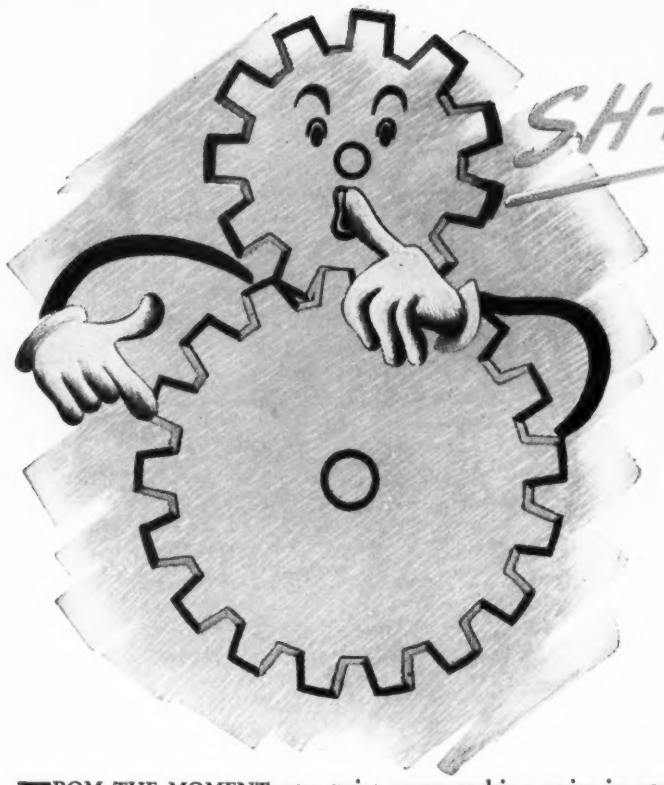
Grease Lubricated	Texaco Stazon B or Texaco Cup Greases or Texaco Star H Grease No. 00
ECCENTRIC BEARINGS, GEARS, BALL BEARINGS AND COUNTERSHAFT	
Warm Weather Operation	Texaco Crusher Oil, Pelican Oil or Texaco Car Oils
Cold Weather Operation	Texaco Algol Oil or Ursa Oils
SUSPENSION AND WEARING RINGS *(At Top of Main Shaft)*	Texaco Car Oils or Texaco Star Greases
GREASE LUBRICATION (In General)	Texaco Star H Grease No. 00 or No. 1
ROLL JOURNALS (130-180°F.)	Texaco Marfak No. 1 or No. 2
ROLL JOURNALS (Above 180°F.)	Texaco Taurak or Hytex Greases
SHAFT BEARINGS	Texaco Marfak No. 1 Texaco Cup Grease No. 3 or Texaco Taurak or Hytex Greases
RING OILED SHAFT BEARINGS	Texaco Aleph, Altair or Aries Oil
TRUNNION BEARINGS	
Wool Yarn Packed	Texaco Crusher Oil, Car Oils or Texaco Stazon B
Otherwise	Texaco Taurak or Hytex Greases
THRUST BEARINGS, ETC.	
Bath Lubricated	Texaco Car Oils
GEARS AND PINIONS	Texaco Thubans Texaco Craters
RING GEAR, DRIVING PINION, ETC.	Texaco Thubans Texaco Craters
BEARINGS	
Grease Lubricated	Texaco Star Greases or Texaco Star H Grease No. 00 or No. 1
Oil Lubricated	Texaco Aleph, Altair or Aries Oil
ECCENTRIC MECHANISMS, BEARINGS & GUIDES	
Grease Lubricated	Texaco Star Greases or Texaco Star H Grease No. 00 or No. 1
Oil Lubricated	Texaco Car Oils
ROLL BEARINGS	Texaco Marfak Texaco Star Greases or Texaco Star H Grease No. 00 or No. 1



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